

Safety of Hyperbaric Medicine in Clinical Scenarios

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Abstract

Hyperbaric therapy is generally considered a safe therapy for the treatment of wounds, mucormycosis, and orthopedic injuries. It is fraught with complications such as barotrauma, pulmonary toxicity, fire hazards, and claustrophobia. This article discusses the safety protocols and preventive aspects on usefulness of this new emerging therapy.

Keywords: Claustrophobia, hyperbaric medicine, safety

Résumé

La thérapie hyperbare est généralement considérée comme une thérapie sûre pour le traitement des plaies, de la mucormycose et des blessures orthopédiques. Elle entraîne de nombreuses complications telles que le barotraumatisme, la toxicité pulmonaire, les risques d'incendie et la claustrophobie. Cet article traite des protocoles de sécurité et des aspects préventifs sur l'utilité de cette nouvelle thérapie émergente.

Mots-clés: Claustrophobie, médecine hyperbare, sécurité

INTRODUCTION

Hyperbaric medicine is now emerging as a new modality of treatment in the modern era for ailments which are resistant to conventional modes of therapy. This therapy is associated with a multitude of side effects such as barotrauma, pulmonary toxicity, claustrophobia, and oxygen toxicity.

Severity of the ulcers precluded by prolonged duration and vascular compromise delay healing of chronic wounds secondary to osteomyelitis or mucor. These factors entail the need of novel interventions to speed up healing.

The use of this device entails risk and hazards to the operating personnel and health-care workers. Fire safety is of paramount importance in using this mode of therapy. Compression and decompression are the other issues which should be borne in mind which can reduce the efficiency of the patient and personnel involved in the use of this high pressure system.

A safety policy must be implemented in every hyperbaric center. All technicians must ensure the safety of the patients

during sessions by following written informed consents and emergency evacuation practices. The usefulness of any safety system in a government institute will be its training, education, and compliance of the personnel.

The number of hazards in hyperbaric unit is related to the operating system in use, i.e., pipes, chambers, compressors, and gas storage. Proper design, maintenance, and correct installation are the gold standard. The service engineer should be properly trained to manage the defaults in the system. Fire can easily occur in a closed chamber, so safety guidelines must be implemented at all levels.

A user friendly tool has been outlined to assess risk in the assesment of operating a hyperbaric facility.^[1]

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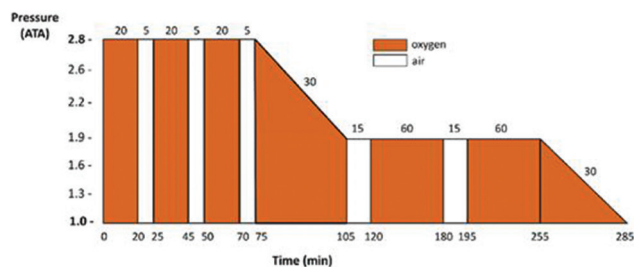
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Table 1: Showing US Navy Table 6

Oxygen toxicity may result from pressures above 0.6 Atmospheric Temperature Absolute (ATA).^[2] US Navy treatment Table 6 is generally employed for this hazard as outlined in Table 1. This table can be used to provide treatment for severe delayed decompression illness at additional breathing cycles at both depths for treating residual defects. It employed 2.8 ATA and 240 minutes of 100 % oxygen.

The aim of this study was to evaluate the incidence of side effects associated with therapy and risk factors in a cohort of patients treated for different indications of hyperbaric therapy in a tertiary institute.

METHODS

This prospective study was done in 106 patients who underwent hyperbaric therapy in Hyperbaric Centre, Department of Burn and Plastic Surgery, AIIMS, Rishikesh, over a period of 2 years. Informed consent and institution ethics committee approval were sought. Participants were first identified by self-reported ethnicity, categorized as Indo-Aryan or non-Indo-Aryan. In the current study, forty participants were included as Indo-Aryan irrespective of self-identified race. The patients enrolled in this program were subjected to a strict pre-anesthesia protocol, chest X-ray, and ENT examination to rule out medical disorders, ear disorders, or tympanic membrane perforation.

Inclusion criteria

Patients in the age group of 18–50 years were included in the study.

Exclusion criteria

- Pregnancy
- Contraindications of hyperbaric therapy
- Patients receiving chemotherapy.

Clinical, laboratory, and medication data were collected at baseline in all the patients. Patients were explained the risks of barotrauma and Valsalva maneuvers were taught to all patients by nursing officers who were enrolled for this therapy. The patients underwent hyperbaric sessions in a multiplace chamber installed by one of the leading manufacturers Tekna USA, with air breaks and pressure settings decided based on the specific indication. Each session was monitored by a technician both outside and inside the chambers and all records were noted down in pro formas. All the sessions were monitored

for complications such as barotrauma, pulmonary toxicity, and claustrophobia. A quality of life questionnaire was filled before and after each session. The primary outcome was defined as no change or a reduction in the participant's size of ulcers or flap healing. Different sessions were given in each category based on the indication.

The primary outcome was the incidence of complete healing, defined as complete re-epithelialization at 10th consecutive visits during the treatment period. Safety outcomes included the assessment of the incidences of adverse events during or after the sessions. Participants were scheduled for return visits every week to receive wound cleansing and debridement with an assessment of wound status, wound size measurement, and physical examination results.

RESULTS

Out of the 106 patients, only four patients reported ear problems in the study. One patient opted out of the study who reported heaviness in his right ear. One patient reported ear pressure after his fifth session and opted out of the study.

Patients with arterial disorders reported an improvement in their pain score after therapy. Ten patients with venous ulcers treated with platelet-rich plasma and adjuvant hyperbaric therapy improved with complete healing of ulcers. An overall improvement in pain and quality of life was observed in mucormycosis patients.

One incidence of claustrophobia was reported by the patient with orthopedic injury. There was no issue of oxygen toxicity or pulmonary injury after the sessions due to the air breaks available with this multiplace chamber. The majority of indications were posttraumatic wounds, mucormycosis, and orthopedic injuries.

DISCUSSION

Hyperbaric therapy is a safe therapy provided guidelines are maintained to ensure the safety of patients from fire or oxygen hazards. The workflow in any hyperbaric facility is modified based on facility needs and capabilities. Clear roles to each staff member improve scope of practice.

The peak PO₂ for these treatments in this study ranged from 2.6 ATA to 2.9 ATA. 155 oxygen toxicity events occurred in 152 patients, 49 females and 103 males.^[2] The overall incidence of oxygen toxicity was 7.1/100 recompressions.

Two fires occurred in diving bells, eight occurred in recompression (or decompression) chambers, and 25 occurred in clinical hyperbaric chambers.^[3] No fires have been reported in vicinity of the facility for 2 years.

The overall per-session incidence was 721:100,000 events: Sessions (0.72%). The main complication was middle ear barotrauma, which occurred in 9.2% of patients and in 0.04% of sessions.^[4]

Two hundred and sixty-two patients experienced middle ear barotrauma after therapy, representing a prevalence of 10.04% and incidence of 0.587% in females.^[5]

The two most frequent and benign side effects comprise middle ear barotrauma, which has been noted in up to 2% of treated patients, and can be prevented or minimized by teaching autoinflation techniques, and other is claustrophobia.^[6]

More than 17% of all patients experienced ear pain or discomfort as an expression of problems in equalizing the middle ear pressure.^[7] Oxygen toxicity of the CNS manifested by generalized seizures affected four patients.

Independent risk factors of cessation due to pressure equalization problems were identified as age more than 61 years, female sex, and interval between symptoms and the 1st day of hyperbaric therapy.^[8] Weaver and Churchill reported three cases of pulmonary edema with HBO therapy with one fatality.^[9]

The hyperbaric oxygen-treated group in this study in patients with burns had an average decrease in the length of stay of 14.8 days, and a reduction of surgical procedures of 39%.^[10]

Side effects have been enumerated in various studies, but myopia, ear barotrauma, and rarely oxygen toxicity have been reported.^[11]

Our study has outlined barotrauma as the main problem associated with this therapy in four patients and advocates proper usage of Valsalva maneuver before each session and the use of decongestants before each session.

Hyperbaric oxygen therapy (HBOT) as a modality shows promising role in ulcerative colitis patients by not only improving plasma and tissue oxygen content but also improve the oxygen levels of blood reaching inflamed bowel.^[12]

The technician who operates the chamber must clearly understand the possibility for accidents, how to anticipate and prevent those dangers, and up-to-date knowledge to ensure safe and secure operation of the chamber and its associated equipment. The technician inside the chamber is trained to remove anxiety, teach Valsalva maneuvers, and ensure the safety of personnel by initiating safety alarm system if there is malfunction or patient morbidity.

Safety policies should be in place with regard to the proper clothing patients should wear or removal of ornaments or metallic objects before entering the chamber. Staff should be trained to inspect any personal accouterments and bedding equipment as required. Besides this, designated areas for storage of patient valuables should be made available. Proper entry and exit of patients are to be ensured.

The HBOT department must be free of any fall, trip, or slip hazards that pose a risk of injury to patients. In addition, staff must be adequately trained in accessing and controlling all equipment related to the operation of the HBOT department. No history of falls or trips was seen in our study.

During treatments, the hyperbaric chamber is a high-oxygen environment. In addition, there is always fuel present in the

form of cloth, paper, etc. Hence, the potential for a fire to occur is always present during a treatment. Frequent checks should be inculcated in all the sessions.

Due to the enclosed and pressurized nature of the chamber, it is impossible to quickly open the door when the chamber is pressurized, so rapid evacuation is not always possible. Being a multiplace chamber and presence of air seal with a technician inside the chamber, there was no incidence of any untoward incident in any of the sessions.

Patients and ancillary staff are instructed to wear 100% cotton garments since these minimize the chance of static spark and subject to releasing toxic fumes or melting on to skin if exposed to fire.

Strict operational protocols, including pre-HBO2 therapy evaluations and in-chamber monitoring, are essential and improve the patient safety. When applied judiciously with a proper pre-assessment, HBO2 therapy can be considered one of the safest medical treatments available today.

For instance, if patients require transfer assistance through the use of slide boards, falls can be prevented by instructing health-care workers to take all precautions in shifting patients in and out of the chamber.

Claustrophobia is present in about 2% of the general population, which may cause some degree of confinement anxiety inside the hyperbaric chamber. Mild sedation is often required for these patients to continue with daily hyperbaric oxygen treatment. Pulmonary and neurological manifestations of oxygen toxicity are often cited as major concerns. Seizure is rare but has potentially severe consequences.

A careful risk assessment, supervision, and control of all operations by trained personnel are necessary, implementation, and review of safe systems of work and particular reference to information, instruction, and training of all staff should be the norm. Hyperbaric oxygen is a limb and sometimes life-saving therapy. HBO therapy significantly reduces the length of the patient's hospital stay, amputation rate, and wound care expenses.

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Conflicts of interest

There are no conflicts of interest.

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